Texscan

OPERATING AND INSTRUCTION MANUAL
FOR
REFLECTION COEFFICIENT BRIDGES

MODELS RCB-3, RCB-3/75, RCB-4, KRCB-3, KRCB-3/75, and KRCB-4

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317/357-8781

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SECTION 1

SPECIFICATIONS

1.1 FREQUENCY RANGE

RCB-3	0.5 MHz to 1 GHz
RCB-3/75	0.5 MHz to 1 GHz
RCB-4	0.5 MHz to 2.5 GHz

1.2 IMPEDANCE

RCB-3	50 ohm
RCB-3/75	75 ohm
RCB-4	50 ohm

NOTE: The specified bridge impendances are correct only when the signal is leveled at the bridge input (Figure 1). Without such external leveling the 50-ohm bridges appear as 83.3 ohms, and the 75-ohm bridge appears as 125 ohms.

1.3 RETURN LOSS (UNBALANCE)

RCB-3	40 dB
RCB-3/75	40 dB
RCB-4	40 dB @ 1 GHz, 25 dB @ 2.5 GHz

1.4 OUTPUT POLARITY

Negative (all models)

1.5 ALC DETECTOR POLARITY

Negative (all models).

1.6 OUTPUT TIME CONSTANT

10 usec (all models).

1.7 STANDARD CONNECTORS

RCB-3 & RCB-4

RF Input	Type N Female
Z1 Test Port	Type N Female
Z2 Test Port	Type N Female
DC Output	BNC Female
ALC Output	BNC Female

RCB-3/75

RF Input	70 ohm Type N Female
Z1 Test Port	70 ohm Type N Female
Z2 Test Port	70 ohm Type N Female
DC Output	BNC Female
ALC Output	BNC Female

1.8 SENSITIVITY (Typical output with o.5V rms input @ 1 GHz)

1.1:1 VSWR	2mV
1.2:1 VSWR	8mV
1.5:1 VSWR	30mV
2.0:1 VSWR	65mV

1.9 WEIGHT

RCB-3 & RCB-4	6 oz.
RCB-3/75	8 oz.

1.10 REFLECTION COEFFICIENT KITS

Texscan Reflection Coefficient Bridges are available with mismatches.

QUANTITY	KRCB-3	KRCB-4	KRCB-3/75
1	RCB-3	RCB-4	RCB-3/75
2	MF-50 1.0:1	MF-50 1.0:1	MF-75 1.0:1
1	MF-50 1.2:1	MF-50 1.2:1	MF-75 1.2:1
1	MF-50 1.5:1	MF-50 1.5:1	MF-75 1.5:1
1	MF-50 2.0:1	MF-50 2.0:1	MF-75 2.0:1

SECTION 2

GENERAL DESCRIPTION

2.1 GENERAL DESCRIPTION :

The reflection coefficient bridges are broad band RF comparators. These devices develop a DC potential with respect to ground which is proportional to the degree of unbalance in the arms of the bridge circuit. The bridges provide DC isolation to prevent undesired loading of the circuitry by associated test equipment.

2.2 THEORY OF OPERATION (ALL MODELS)

The bridge circuit is comprised of R3, R4, the external reference and the unknown impedance. C2 and C3 isolate the bridge arms for DC. A voltage is generated across CR1 which is proportional to the degree of mismatch between the reference termination and the unknown termination. R2 provides a high impedance ground return which minimizes bridge loading. R1 isolates the oscilloscope loading affects. CR2 and C4 form a peak detector which provides an external leveling voltage for the sweep generator input. C1 bypasses any RF components before coupling to the oscilloscope.

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SECTION 3

INITIAL SETUP AND CALIBRATION

3.1 PRELIMINARY SETUP - SEE FIGURE 1

3.1.1	Connect RCB	To:
	RF IN	Sweep generator RF output
	DC OUT	Sweep generator VIDEO IN
	MONITOR OUT	Sweep Generator EXT MONITOR
	Z1	50 or 75 ohm reference termination
	Z2	1.0:1 VSWR mismatch
3.1.2	Connect Sweep Generator	To:
	Scope VERT	Oscilloscope vertical INPUT
	Scope HORIZ	Oscilloscope Horizontal INPUT
3.1.3	Set Sweep Generator	To:
	Center Freq.	Range desired
	Sweep width	As desired
	MONITOR	EXTERNAL
	MARKERS	ON (as desired)
	Attenuators	As required
3.1.4	Oscilloscope	To:
	Vertical coupling	DC coupling
	Vertical range	As necessary to display trace
	Horizontal gain	As required

3.2 Calibrate the oscilloscope graticule in VSWR as follows:

3.2.1 Connect a 50 ohm termination to Z2 (1.0:1 VSWR)

3.2.2 Adjust the oscilloscope for a base line trace at the top of the screen.

3.2.3 Connect a 1.05:1 VSWR calibrated mismatch to Z2.

3.2.4 Note the position of the trace on the graticule and mark the position with grease pencil or other suitable marking device.

3.2.5 Repeat 3 and 4 with as many calibrated mismatches as required to cover the VSWR range needed.

SECTION 4

APPLICATIONS

4.1 It is possible to determine several important parameters of four terminal devices such as filters, transmission lines and amplifiers using a reflection coefficient bridge and associated equipment. The following parameters may be determined.

1. VSWR
2. Structural return loss.
3. Insertion loss.
4. Load VSWR for measured generator VSWR.

The application of these parameters may be applied to many facets of electronic testing, for example:

Antenna measurements

Antenna matching

Return loss for CATV

Insertion loss of devices

Cable testing

Determination of amplitude and phase difference between a known and unknown device.

4.2 EQUIPMENT REQUIRED:

Sweep Generator w/markers	Texscan VS-90 or equivalent
Oscilloscope	Texscan DU-88 or equivalent
Calibrated attenuators	Texscan KFP series or LA series or equivalent
Calibrated mismatches	Texscan MF series or equivalent
Calibrated RF Source	
Electronic Switch	Jerrold/Texscan TC-2 or equivalent
Calibrated phase shifter	(Special)

4.3 ANTENNA MEASUREMENTS

4.3.1 Perform the preliminary setup and calibration. See Figure 1.

4.3.2 Connect the antenna to be tested to Z2.

4.3.3 Read the VSWR from the oscilloscope.

4.3.4 Insert markers to determine the frequency vs VSWR characteristics of the antenna under test.

4.3.5 If the length of cable between the antenna and the RCB is great, the apparent VSWR at the bridge is not true antenna VSWR. Refer to Figure 3 for VSWR reduction vs cable attenuation. A method of determining cable attenuation is provided in a following section. Manufacturer's data may also be consulted for attenuation characteristics of a particular cable. Consult Figure 4 for correlation of power loss due to VSWR.

4.4 STRUCTIONAL RETURN LOSS OF CABLE

Structional return loss (SRL) is caused by imperfections in cable construction. Reflections occur from variations in cable diameter, dielectric imperfections, sharp bends, conduction misplacement, etc. These reflections prevent a certain portion of the incident power from reaching the load. Structural return loss is a measure of the quality of a cable.

NOTE: Structural return loss is one component of return loss. Load and generator mismatch contribute to the total return loss unless they are made equal to the characteristic impedance of the cable being measured.

4.4.1 Perform the initial setup and calibration. See Figure 1.

4.4.2 Terminate the cable in its characteristic impedance.

4.4.3 Connect the cable to Z2.

4.4.4 Measure the VSWR at the frequencies desired.

4.4.5 Refer to Figure 2 and read SRL in terms of observed VSWR.

4.5 INSERTION LOSS

In cables, insertion loss is comprised of resistive losses (skin effect) and dielectric losses. Each of these parameters increases with frequency. In filters the lumped constants have similar losses. The insertion loss may be determined by observing the reflections from an open or short circuited output. The initial assumption is that the cable or device is matched to the generator.

4.5.1 Perform the initial setup and calibration.

4.5.2 Open Circuit (or short circuit) one end of the device.

4.5.3 Connect the device to Z2.

4.5.4 Read the VSWR at the desired frequency.

4.5.5 Refer to a table for correlation of VSWR to insertion loss. See Figure 5.

4.6 DETERMINATION OF AMPLITUDE AND PHASE MEASUREMENT

4.6.1 Set up the equipment as shown in Figure 6.

NOTE: A dual trace oscilloscope may be used instead of an electronic switch; however, only one channel will have marker capability. This provides simultaneous monitoring of input and output characteristics for matching purposes.

4.6.2 Remove both the known and unknown devices, connecting the attenuators directly to the RCB.

4.6.3 Adjust the variable attenuator and variable phase shifter to obtain a null in output from RCB-2.

4.6.4 Insert the known and unknown devices per Figure 6.

4.6.5 Adjust the device under test (unknown) until a null is observed at the frequency of interest. The unknown device will not match the known device in attenuation and phase angle.

4.6.5a. Adjust the variable attenuator and variable phase shifter to obtain a null from RCB-2. The difference in attenuation between the fixed attenuator and the variable attenuator indicate attenuation or gain of the device under test. The difference in attenuation between the fixed phase shifter and the variable phase shifter is the phase shift induced by the device under test.

NOTE: Possible applications: Alignment of 0 phase shift filters. Comparison of filter attenuation and phase to a Quality Assurance standard or other specification. Adjustment of amplifier for gain and phase shift.

SECTION 5

ALIGNMENT

5.1 Perform the initial setup and calibration procedure.

5.2 Connect a 1.0:1 VSWR termination to Z1 and Z2.

5.3 Remove the cover of the RCB.

5.4 In the RCB-3 or RCB-4 the tuning line tabs may be adjusted to balance the bridge. Adjust the tuning line tabs and component lead dress for minimum output across the frequency range desired. The tuning line tabs are indicated as a ghost capacitor on Figure 7. The output at the DC out port should be at least 40 dB below the reference output. Reference output voltage may be measured by placing a CD-51 detector at Z2.

5.5 The RCB-3/75 has no tuning lines. Component lead dress only should be adjusted to align the RCB-3/75. The Z2 to DC out isolation should be at least 40 dB. See Figure 8.

NOTE: Since the RCB cover plate also provides some distributed capacity, the cover should be replaced after each adjustment and all isolation measurements made with the cover in place.

This completes the alignment procedures.

SECTION 6

DOCUMENTATION

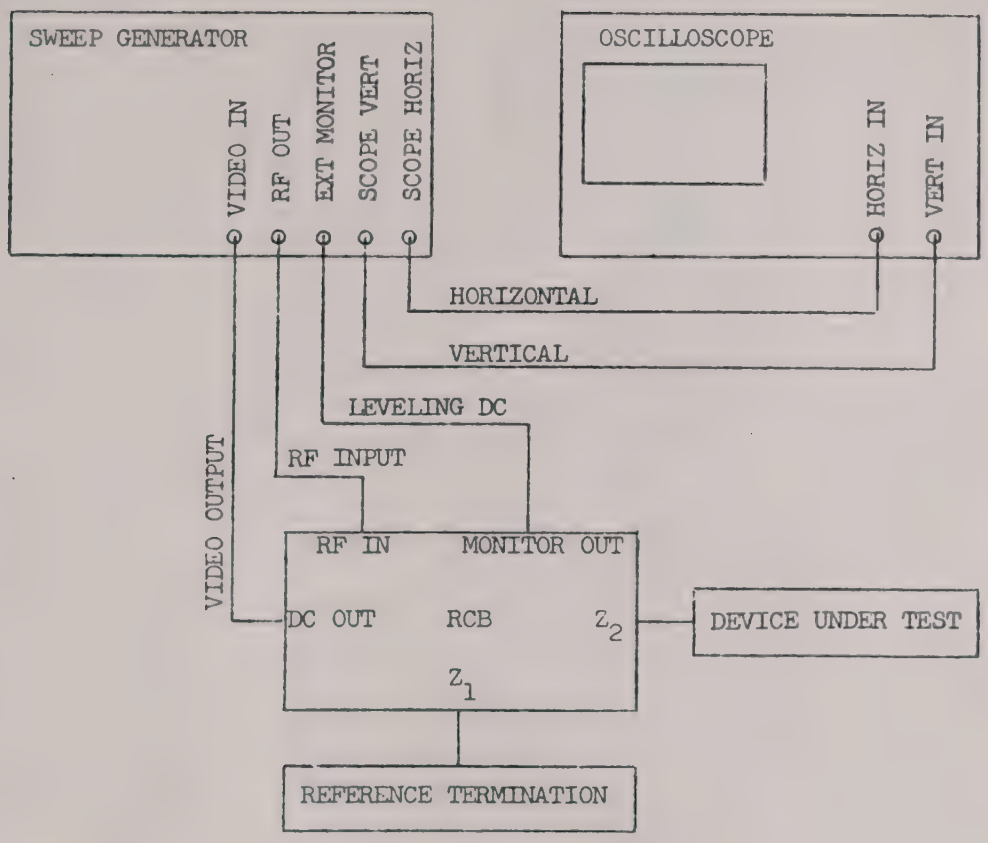

FIGURE 1: INITIAL SETUP FOR CALIBRATION

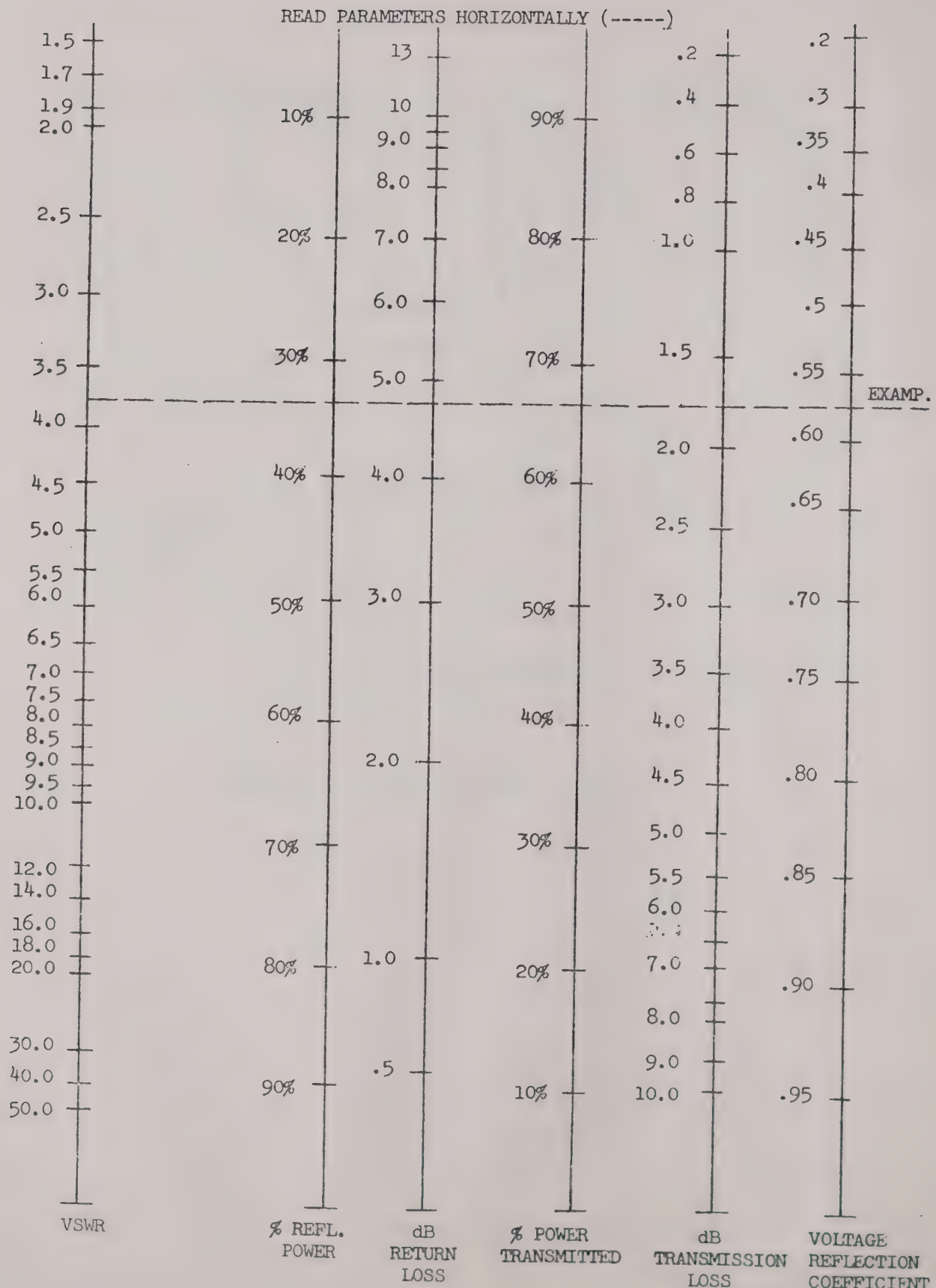

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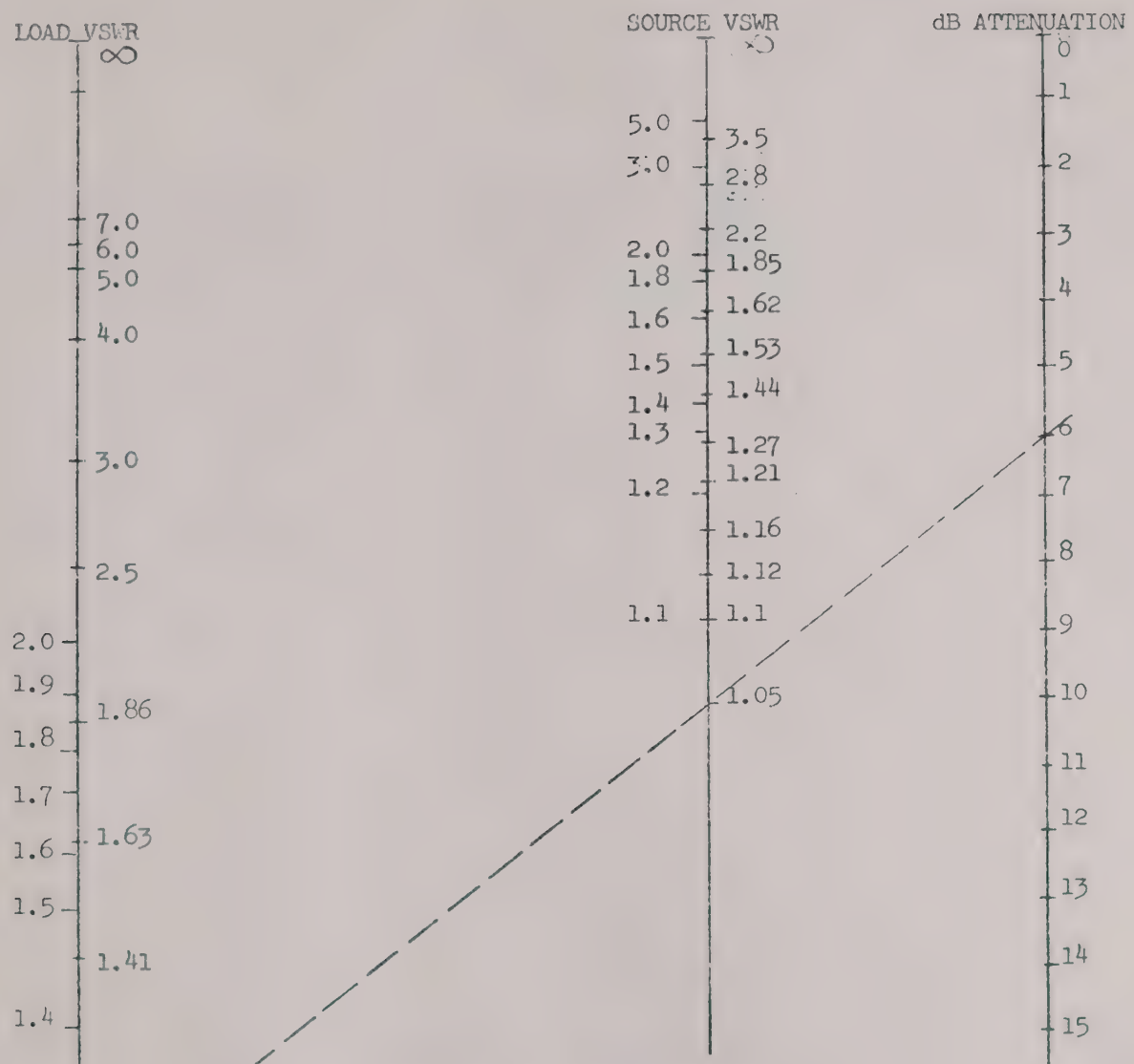
FIGURE 2: PARAMETERS RELATED TO VSWR

RCB



NOMOGRAPH OF VSWR REDUCTION
FOR GIVEN ATTENUATION

$$\text{Coth}^{-1} S_1 = \text{Coth}^{-1} S_2 + \frac{\alpha}{8.686}$$

When S_1 = VSWR AT THE SOURCE

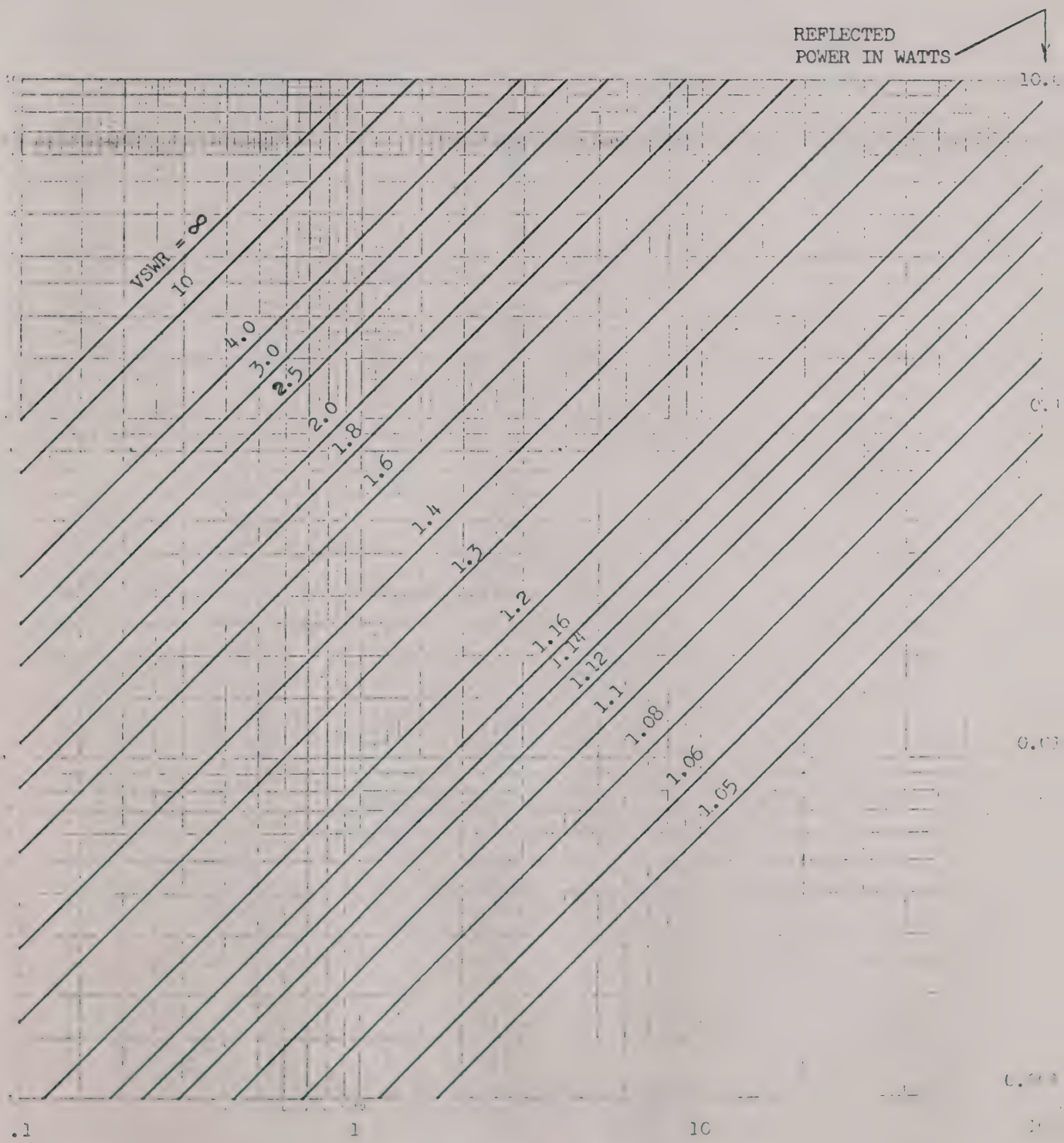
S_2 = VSWR AT THE LOAD

α = ATTENUATION IN dB

BASIC EQUATION:

$$-10 \log_{10} \left(\frac{S_1 + 1}{S_1 - 1}\right) = -10 \log_{10} \left(\frac{S_2 + 1}{S_2 - 1}\right) \alpha$$

FIGURE 3



FORWARD POWER IN WATTS

FIGURE 4: POWER VALUES -vs- VSWR

RCB

$$SRL = 20 \log_{10} \frac{V \text{ REFLECTED}}{V \text{ REFERENCE}} \qquad LOSS = -10 \log \frac{(VSWR-1)}{(VSWR+1)}$$

V REFLECTED / V REFERENCE	SRL dB	VSWR	VSWR	INSERTION LOSS
1.12	1	17.40	1.05	-16.3
1.26	2	8.72	1.1	-13.2
1.413	3	5.85	1.2	-10.4
1.585	4	4.42	1.3	- 8.7
1.778	5	3.57	1.4	- 7.8
1.995	6	3.00	1.5	- 7.0
2.239	7	2.62	1.6	- 6.4
2.512	8	2.32	1.7	- 5.9
2.818	9	2.10	1.8	- 5.5
3.162	10	1.92	1.9	- 5.1
3.584	11	1.78	2.0	- 4.8
3.981	12	1.67	2.5	- 3.7
4.467	13	1.58	3.0	- 3.0
5.012	14	1.50	3.5	- 2.6
5.623	15	1.43	4.0	- 2.2
6.310	16	1.38	4.5	- 1.9
7.079	17	1.33	5	- 1.8
7.943	18	1.29	6	- 1.5
8,931	19	1.25	7	- 1.2
10.00	20	1.22	8	- 1.1
11.22	21	1.20	9	- .96
12.59	22	1.17	10	- .88
14.13	23	1.15	20	- .43
15.85	24	1.13	30	- .29
17.78	25	1.12	40	- .23
19.95	26	1.11		
22.39	27	1.09		
25.12	28	1.08		
28.18	29	1.07		
31.62	30	1.06		
35.48	31	1.058		
39.81	32	1.051		
44.67	33	1.046		
50.12	34	1.041		
56.23	35	1.036		
63.10	36	1.032		
70.79	37	1.029		
79.43	38	1.026		

FIGURE 5: TABLE OF STRUCTURAL RETURN LOSS
AND INSERTION LOSS VS VSWR

FIGURE 6: SETUP FOR DETERMINING AMPLITUDE AND PHASE CHARACTERISTICS

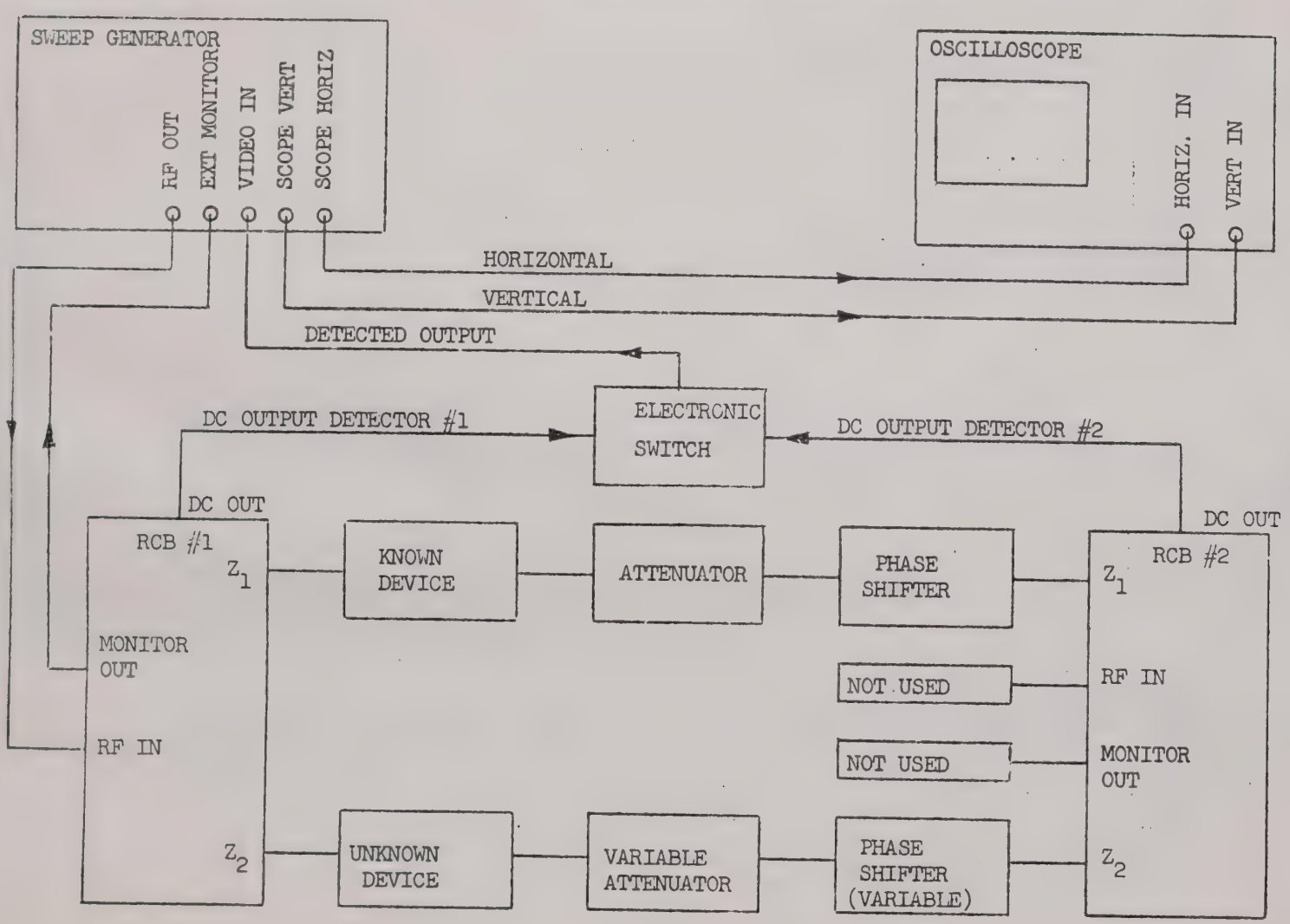
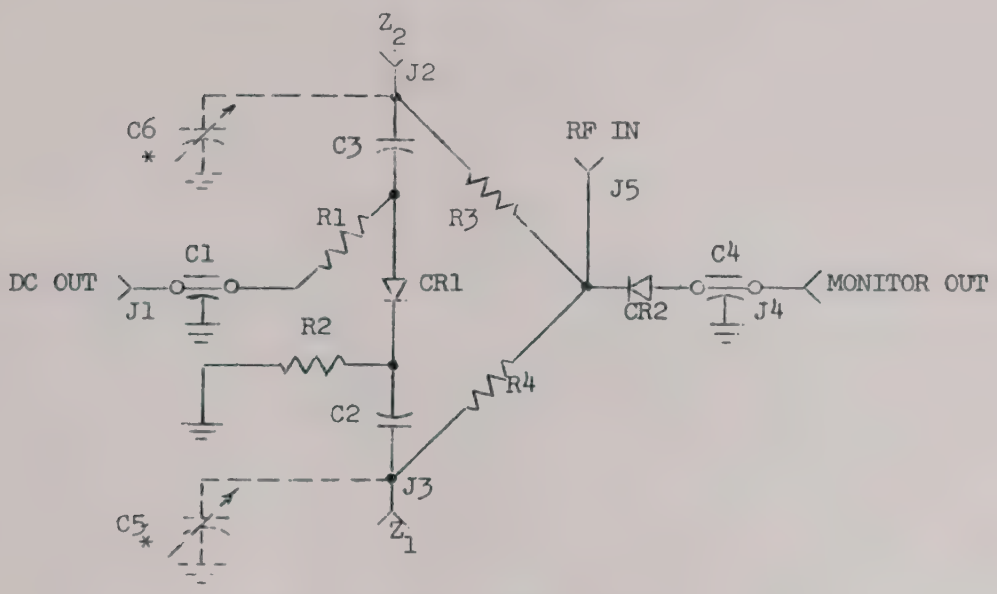


FIGURE 7: RCB-3 AND RCB-4 SCHEMATIC



RCB-3 AND RCB-4 PARTS LIST

CIRCUIT REF. NO.	TEXSCAN STOCK NO.	DESCRIPTION
C1	012-002	Capacitor, feedthru, 1000pF
C2	012-048	Capacitor, fixed, 300pF
C3	012-048	Capacitor, fixed, 300 pF
C4	012-002	Capacitor, feedthru, 1000pF
C5	A215-012	*See Paragraph 5.4
C6	A215-012	*See Paragraph 5.4
CR1	025-001	Diode, 1N82AG
CR2	025-001	Diode, 1N82AG
J1	A020-032	Connector, BNC
J2	020-059	Connector, N
J3	020-059	Connector, N
J4	A020-032	Connector, BNC
J5	020-059	Connector, N
R1	045-751	Resistor, 10Kohm, $\frac{1}{4}$W, 5%
R2	045-751	Resistor, 10Kohm, $\frac{1}{4}$W, 5%
R3	047-009	Resistor, 49.9 ohm, $\frac{1}{4}$W, 1%
R4	047-009	Resistor, 49.9 ohm, $\frac{1}{4}$W, 1%

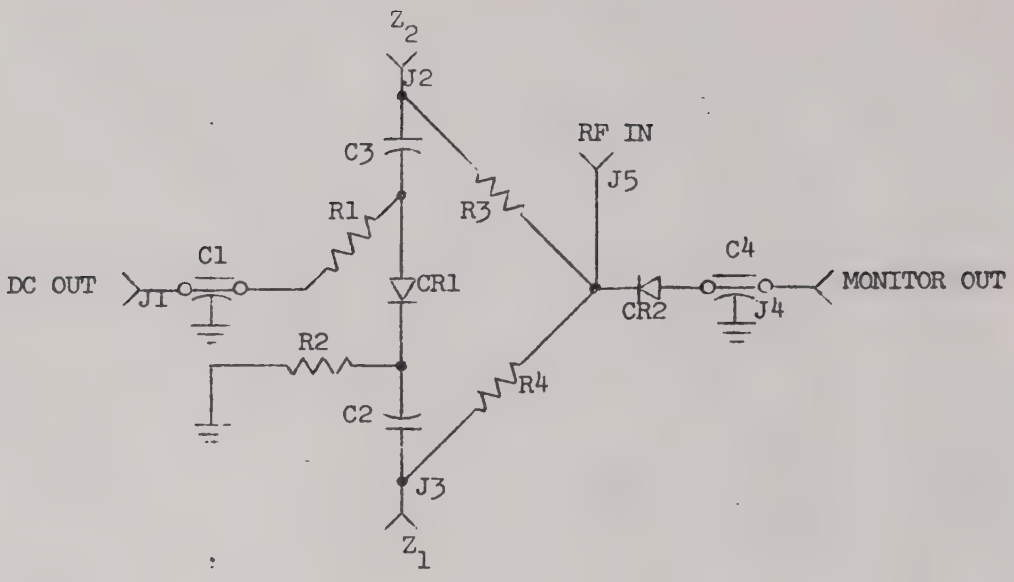


FIGURE 8: RCB-3/75 SCHEMATIC

CIRCUIT REF. NO.	TEXSCAN STOCK NO.	DESCRIPTION
C1		Capacitor, Factory Selected
C2	012-108	Capacitor, 1000pF
C3	012-108	Capacitor, 1000pF
C4		Capacitor, Factory Selected
CR1	025-002	Diode, 1N82
CR2	025-002	Diode, 1N82
J1	020-011	Connector, BNC
J2	020-054	Connector, 70 ohm N
J3	020-054	Connector, 70 ohm, N
J4	020-011	Connector, BNC
J5	020-054	Connector, 70 ohm, N
R1	046-151	Resistor, 10Kohm, $\frac{1}{2}$W, 5%
R2	046-151	Resistor, 10Kohm, $\frac{1}{2}$W, 5%
R3	047-123	Resistor, 75 ohm, $\frac{1}{4}$W, 1%
R4	047-123	Resistor, 75 ohm, $\frac{1}{4}$W, 1%

WARRANTY

Texscan Corporation warrants that each part of this product (except vacuum tubes and batteries) will be free from defects in material and workmanship under normal use and service. Texscan Corporation's obligation under this warranty shall be limited to repairing or replacing, F.O.B. Indianapolis, Indiana, each part of the product (except vacuum tubes and batteries) which is defective, provided that buyer gives Texscan written notice of such defect within a period of one year commencing with the delivery of the product by Texscan Corporation. The remedy set forth herein shall be the only remedy available to the buyer for breach of this warranty, and in no event shall Texscan Corporation be liable for incidental or consequential damages for such breach. This warranty shall not apply to any part of the product which, without fault of Texscan Corporation, has been subject to alteration, failure caused by a part not supplied by Texscan Corporation, accident, fire or other casualty, negligence or misuse, or to any part rather than as a result of defect.

Except for warranties set forth above, and the warranties, if any, available to the buyer from the persons who supply Texscan Corporation any vacuum tubes or batteries contained in the product, there are no warranties, express or implied (including, without implied limitation, any implied warranties of merchantability or fitness), with respect to the condition of the product or their suitability for the use intended for them by the buyer or by a purchaser from the buyer.

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